A Multisensor System for Detection and Characterization of UXO

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RESEARCH OBJECTIVES

The objective of this field demonstration project is to show that a multisensor active electromagnetic (AEM) system can be built to detect and extract essential information about a metallic object in the ground, so as to discriminate unexploded ordnance (UXO)-like bodies from non-UXO scrap. Further, we hope to demonstrate that the system can perform target characterization from a single position of the sensor platform above a target. This system will equal or exceed the detection capabilities of existing systems, but with the important advantage of being able to quantitatively determine size and principal polarizabilities of the target. The cart-based system is designed to detect and characterize UXO in the 20 mm to 150 mm size range.

APPROACH

Drawing on the experience gained in the completion of Strategic Environmental Research and Development Program (SERDP) Project UX-1225 (Detection and Classification of Buried Metallic Objects), we are building an optimally designed field prototype system. The system employs two orthogonal vertical loop transmitters and a pair of horizontal loop transmitters vertically spaced 0.7 m apart. Eight vertical field detectors are deployed in the plane of each of the horizontal loops and are arranged to measure the offset vertical gradients of the fields. The system employs a bipolar half-sine pulse-train current waveform, and the detectors are dB/dt induction coils designed to minimize the transient response of the primary field pulse. The sensor coil pairs are located on symmetry lines through the center of the system, so that they detect identical primary fields (for all three transmitters) during the on-time of the pulse. These coil pairs are wired in opposition to produce a null output. Secondary fields from the target have a large gradient that is easily measured in the differenced output. Field prototype sensors are critically damped and resonant at about 20 kHz, and resonant frequency allows a 270 Hz waveform repetition rate and a duty factor of about 20%. The location and orientation of the three principal polarizabilities of a target can be recovered from a single position of the transmitter-receiver system. Further characterization of the target is obtained from the broadband response.

ACCOMPLISHMENTS

We have developed a field-prototype active EM system that can extract from the measurements the best possible estimates of the location, size, shape, and metal content of a buried metallic object, in the presence of an interfering response from the ground and/or non-UXO metallic objects. The prototype system has been tested in the laboratory with very encouraging results. This project received the SERDP Project of the Year award in the UXO Field at the Partners in Environmental Technology Symposium in Washington on December 2, 2004. A rigorous field test is under way and will be followed by a demonstration survey at an Environmental Security Technology Certification Program (ESTCP) standard test site.

RELATED PUBLICATIONS

Smith, J.T., H.F. Morrison, and A. Becker, Parametric forms and the inductive response of a permeable conducting sphere. Journal of Env. and Engin. Geophysics, 9, 213–216, 2004a. Berkeley Lab Report LBNL-54621.

Smith, J.T., H.F. Morrison, and A. Becker, Resolution depths for some transmitter-receiver configurations. IEEE Trans. Geosci. Remote Sensing, 42, 1215–1221, 2004b. Berkeley Lab Report LBNL-51574.

Smith, J.T., H.F. Morrison, and A. Becker, Optimizing receiver configurations for resolution of equivalent dipole polarizabilities *in situ*. IEEE Trans. Geosci. Remote Sensing (submitted), 2005. Berkeley Lab Report LBNL-54585.

ACKNOWLEDGMENTS

This work was supported by the Office of Management, Budget, and Evaluation, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098, and the U.S. Department of Defense under Strategic Environmental Research and Development Program Project No. UX-1225 and Contract No. W74RDV30452524.